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Live Fire Evaluation of the Expeditionary Fire Suppression System (EFSS); Phase I

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14. ABSTRACT

On behalf of AAC/WMO, the Air Force Research Laboratory evaluated the Expeditionary Fire Suppression System (EFSS). The EFSS is a modified-commercial, combined agent system that can be mounted on an Air Force P-20 truck or heavy duty, general purpose truck. The system uses AFFF-based compressed air foam and PKP dry chemical. Phase I evaluated the effectiveness of the modified-commercially available EFSS on live fires on static pool and running fuel fires. The EFSS performed well in the live fire evaluations conducted at Tyndall AFB, FL. The system consistently showed the capability to extinguish both pool and running fuel fires. Several minor problems were encountered with the system but were quickly resolved by the manufacturer and the equipment was put back into service. Issues with the filters, switch covers and the additional capacity on the high pressure air will need to be addressed by the manufacturer in subsequent units.

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Abstract

On behalf of AAC/WMO, the Air Force Research Laboratory evaluated the Expeditionary Fire Suppression System (EFSS). The EFSS is a modified-commercial, combined agent system that can be mounted on an Air Force P-20 truck or heavy duty, general purpose truck. The system uses AFFF-based compressed air foam and PKP dry chemical. Phase I evaluated the effectiveness of the modified-commercially available EFSS on live fires on static pool and running fuel fires. The EFSS performed well in the live fire evaluations conducted at Tyndall AFB, FL. The system consistently showed the capability to extinguish both pool and running fuel fires. Several minor problems were encountered with the system but were quickly resolved by the manufacturer and the equipment was put back into service. Issues with the filters, switch covers and the additional capacity on the high pressure air will need to be addressed by the manufacturer in subsequent units.

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Summary

On behalf of AAC/WMO, the Air Force Research Laboratory evaluated the Expeditionary Fire Suppression System (EFSS). The EFSS is a modified-commercial, combined agent system that can be mounted on an Air Force P-20 truck or heavy duty, general purpose truck. The system is designed to be a lightweight yet powerful expeditionary fire fighting capability that is ruggedized for air-insert and/or air-delivery. The system uses AFFF-based compressed air foam and PKP dry chemical. Other features include: operability in separate and combined application with concentric fixed-orifice nozzle turret, handline in austere deployed environments (such as, but not limited to extreme weather), and options for a remote-controlled turret and a remote sensing/fire suppression capability. Also included is a multi-platform skid unit for mounting on a variety of platforms.

The purpose of this evaluation is to conduct the fire fighting effectiveness of modified-commercially available EFSS, using the Air Force Research Laboratory (AFRL) Combined Agent Fire Fighting System (CAFFS) as a baseline.

This test plan covers the evaluation of the EFSS handline and turret operations for fire fighting adequacy using the CAFFS developed by AFRL Fire Research as the baseline.

Operational adequacy for fire fighting includes:

- 3500 ft^2 static pool fires (3)
- 3500 ft^2 static pool fires with F100 engine nacelle running fuel fire (3)
- 7000 ft^2 static pool fires (3)

The EFSS performed well in the live fire evaluations conducted at Tyndall AFB, FL. The system consistently showed the capability to extinguish both pool and running fuel fires. Several minor problems were encountered with the system but were quickly resolved by the manufacturer and the equipment was put back into service. Issues with the filters, switch covers and the additional capacity on the high pressure air will need to be addressed by the manufacturer in subsequent units.

1 Introduction

1.1 Background

The Air Force is evaluating a Expeditionary Fire Suppression System (EFSS). The EFSS is envisioned to be a modified-commercial, combined-agent system that can be mounted on an Air Force P-20 truck or heavy duty, general purpose truck (Figure 1). The system is designed to be a lightweight yet powerful expeditionary fire fighting capability that is ruggedized for air-insert and/or air-delivery and capable of extinguishing a 7000 ft^2 JP-8 pool fire within 45 seconds of fire fighting. The system uses AFFF-based compressed air foam and PKP dry chemical. Other features include: operability in separate and combined application with concentric fixed-orifice nozzle turret, handline in austere deployed environments (such as, but not limited to extreme weather), and options for a remote-controlled turret and a remote sensing/fire suppression capability. Also included is a multi-platform skid unit for mounting.

Figure 1. The Expeditionary Fire Suppression System Mounted on a P-20.

1.2 Purpose

The purpose of this evaluation is to conduct a fire fighting (Phase I) and performance effectiveness (Phase II) of modified-commercially available EFSS, using the Air Force Research Laboratory (AFRL) Combined Agent Fire Fighting System (CAFFS) as a baseline (See DTIC report AFRL-ML-TY-TR-2004-4511, Performance Evaluation of the Combined Agent Fire Fighting System).

1.3 Scope

This technical report covers the evaluation of the EFSS handline and turret operations for fire fighting adequacy using the CAFFS developed by AFRL Fire Research as the baseline.

Operational adequacy for fire fighting includes:

- 3500 ft^2 static pool fires (3)
- 3500 ft^2 static pool fires with F100 engine nacelle running fuel fire (3)
- 7000 ft^2 static pool fires (3)

2 Live Fire Test Procedures

2.1 Pool water depth: one inch above concrete pad.

2.2 Pool fuel volume: 0.15 gallons of JP-8 fuel per ft^2 (Table 1).

Table 1. Fuel Usage for Each Pool Fire.

Fire Coverage (Sq. Ft)	3500	7000
JP-8 per test (Gallons)	500	1000

2.3 Fuel flow rate for F100: 5 gpm.
2.4 Fire Pit Area: 7000 ft^2
2.5 Pre-burn time: Variable. Pre-burn time may fluctuate depending on wind conditions and residual foam in the pit. Exact pre-burn times will be recorded on the data sheet.
2.6 Foam Agent: 3M MIL-SPEC 3% AFFF
2.7 Dry Chemical Agent: Chemguard Purple K Dry Chemical (PKP)
2.8 Live Fire Test Procedures: The EFSS was reserviced, the cameras were positioned, weather conditions were documented, the fuel was spilled, the torch was used to the light the fuel immediately, the preburn time was counted, the EFSS was used to extinguish the fire and the extinguishment time was noted.
2.9 Fire Pit Clean-out procedures:
A water line will be used to move excess foam and dry chemical to the drain on the north side of the pit. Any remaining foam/dry chemical may be burned off prior to start of next test.
2.10 Excess fuel remaining after the previous test may either be reused in the following evaluation or burned off, at the discretion of the AFRL Test Director.

3 Results

Preburn time: the time from when the torch first lights the fuel to the time agent application begins. All preburn times were recorded from the digital video, with the exception of Test 2D, which does not have a video recorded.

Extinguishment time: the total time to extinguish the fire, including time to navigate around the mockup and pit area. All extinguishment times were recorded from the digital video, with the exception of Test 2D, which does not have a video recorded.

DNE: Did Not Extinguish. Indicates the entire fire was not extinguished before the agents were exhausted.

Handline versus roof turret extinguishment: the following sets of tests showed a trend for faster extinguishment of each fire using the handline versus the roof turret. This trend was also observed with previous combined agent fire evaluations. Several factors contribute to the differences in extinguishment times even though the flow rate of the turret is greater than the handline: the firefighter on the handline has better control of the nozzle and can react more quickly than with the joystick; the firefighter on the handline is closer to the surface of the fire and has a better angle of attack; the firefighter on the handline can more easily navigate around the aircraft and fire area than the vehicle can.

3.1 3500 sq ft Pool Fires Using the Handline

Three half pit pool fires were completed using the handline on the EFSS. Approximately 500 gallons of JP-8 hydrocarbon fuel were used for each fire. The agents were applied either separately, or in combination, to most effectively extinguish the fire.

Problem: The system was charged prior to the start of fire 1A, at which time, the pressure relief valve on the foam tank initiated, indicating excessive pressure in the tank. The pressure at the regulator was higher than the set pressure, indicating the regulator had failed in the on position. Cause: Examination of the regulator by the manufacturer indicated that the ceramic disk in the regulator was bad. Solution: A regulator from EFSS #1 was used to replace the defective regulator so testing could proceed.

Problem: During reservicing after installation of the new regulator, a problem with filling the dry chemical high pressure cylinder was observed and the tank was not pressurizing. Cause: Inspection of the plumbing from the central fill port to the cylinder showed the check valve to the dry chemical tank had a broken spring and the internal components needed to be replaced. Solution: Crash Rescue sent the internal components and AFRL rebuilt/reinstalled the valve.

Test 1A was conducted after the regulator and check valve were replaced. The system operated normally and no problems were observed. The preburn time

was 83 seconds and the extinguishment time was just under 28 seconds (Table 2).

Table 2. Test 1A Summary.

Test No	1A
Date	6-Aug-03
Test Type	3500 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	83.03
Extinguishment Time (sec)	27.87
Wind Speed (mph)	na
Wind Direction	na
Temperature (°F)	na

The EFSS functioned normally during Test 1B. No problems occurred during operation. The preburn time was 65 seconds and the extinguishment time was 17.5 seconds. With many live fire evaluations (in particular, handline operations), the first of a series of fires will always be extinguished slower than subsequent fires due to the firefighter using the first fire to master the technique to most effectively extinguish the fire. This trend is seen in series 1, 3, 5 and 6.

Table 3. Test 1B Summary.

Test No	1B
Date	14-Aug-03
Test Type	3500 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	65.09
Extinguishment Time (sec)	17.50
Wind Speed (mph)	9
Wind Direction	NE
Temperature (°F)	77

During Test 1C, the hose line hit the switch on the panel on the hose reel, turning off the foam and dry chemical application (Figure 2). The switch was manually turned back on and fire fighting was resumed.

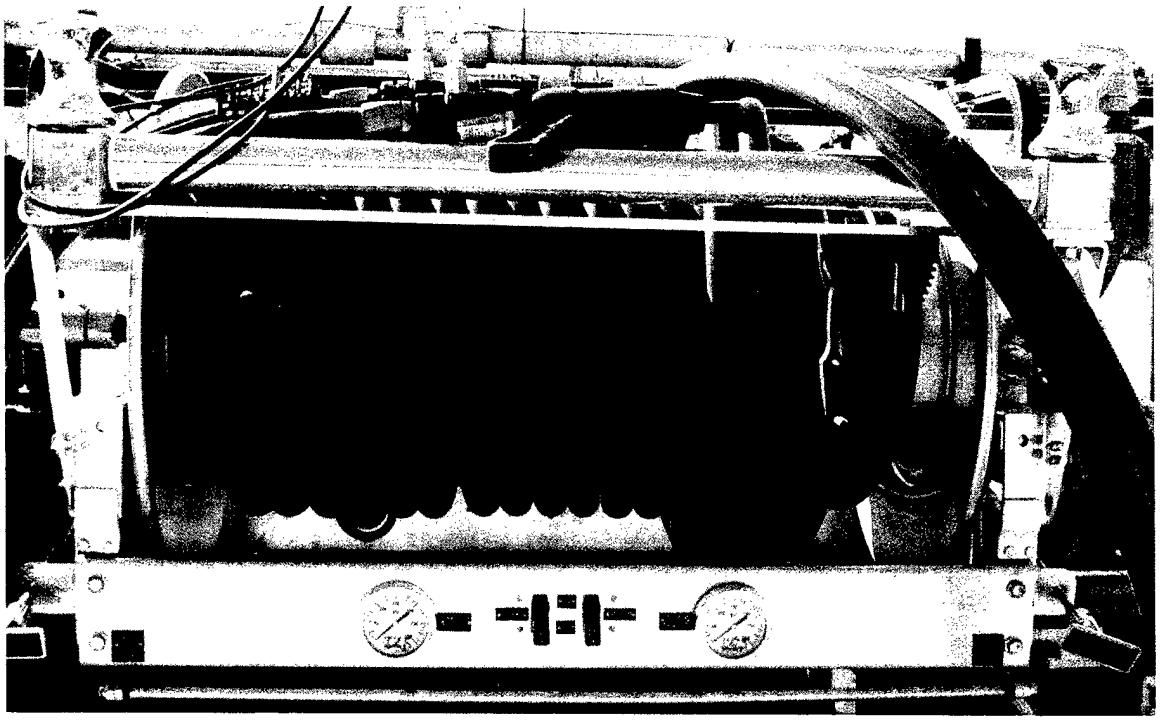

Figure 2. Control Panel on Hose Reel.

Table 4. Test 1C Summary

Test No	1C
Date	14-Aug-03
Test Type	3500 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	137.65
Extinguishment Time (sec)	20.56
Wind Speed (mph)	9
Wind Direction	NE
Temperature (°F)	77

Preburn times were dependent on wind speed, wind direction and any residual foam left in the pit from previous testing. Extinguishment time averaged 21.98 seconds (Tables 2-4).

3.2 3500 sq ft Pool Fires Using the Turret

Three half pit pool fires were completed using the roof turret on the EFSS. Approximately 500 gallons of JP-8 hydrocarbon fuel were used for each fire. The agents were applied either separately, or in combination, to most effectively extinguish the fire.

The 3500 ft^2 pool fire in Test 2A was not extinguished due to operational problems with the EFSS (Table 5).

Problem: During the initial attack, the dry chemical system was not operational and only foam was discharged. The foam flow began to taper off after 15-20 seconds of application until the discharge stopped altogether. The battery charge was checked and found to be low (the battery had not been recharged since the unit was delivered to Tyndall). Cause: AFRL speculated that the power draw for the turret motor diverted power from the valves that pressurize the foam and dry chemical tanks. The foam continued to flow until the initial pressure in the tank was drained. The dry chemical tank was not pressurized at all; therefore, no agent was discharged. Solution: The battery was recharged and the fire was repeated.

Table 5. Test 2A Summary.

Test No	2A
Date	14-Aug-03
Test Type	3500 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	90.09
Extinguishment Time (sec)	DNE
Wind Speed (mph)	12
Wind Direction	ENE
Temperature (°F)	84

The fire in Test 2B was not completely extinguished before the agent was depleted. Evaluation of the fire fighting technique showed that the driver needed to get closer to the edge of the pit to gain more throw distance to better reach the fire at the fuselage of the mockup. The system itself functioned normally and no problems were observed.

Table 6. Test 2B Summary.

Test No	2B
Date	14-Aug-03
Test Type	3500 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	80.06
Extinguishment Time (sec)	DNE
Wind Speed (mph)	na
Wind Direction	na
Temperature (°F)	na

The EFSS functioned normally during the extinguishment of the fire. The preburn time was 72 seconds and the extinguishment time was just under 55 seconds (Table 7).

Problem: After the fire was extinguished and the agent flow was switched off, the foam continued to flow from the turret nozzle. The dry chemical system did not experience any problems during this test. Cause: AFRL and Crash Rescue could not determine the cause of the malfunction and the problem was not observed for the remainder of testing. Solution: The battery level was checked and found to be within normal operating range (the battery was recharged overnight and this was the first fire of the day). The switch was turned back on to pressurize the system and flow more foam, and then switched off. This activated the solenoid valve and the foam flow was finally cut off.

Table 7. Test 2C Summary.

Test No	2C
Date	15-Aug-03
Test Type	3500 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	500
Preburn Time (sec)	72.16
Extinguishment Time (sec)	54.91
Wind Speed (mph)	10
Wind Direction	E
Temperature (°F)	79

During Test 2D, the EFSS functioned normally and no problems were observed. The preburn time was 71 seconds and the extinguishment time was 85 seconds (Table 8).

Table 8. Test 2D Summary.

Test No	2D
Date	2-Sept-03
Test Type	3500 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	350
Preburn Time (sec)	71
Extinguishment Time (sec)	85
Wind Speed (mph)	0
Wind Direction	na
Temperature (°F)	90

During Test 2E, the EFSS functioned normally and no problems were observed. The preburn time was 83.66 seconds and the extinguishment time was 56.37seconds (Table 9). Figures 3 and 4 show the roof turret in operation during a half pit pool fire. The combination of foam and dry chemical provide superior knockdown compared to using either agent alone. The dry chemical provides good initial knockdown while the foam extinguishes, cools and prevents burnback.

Table 9. Test 2E Summary.

Test No	2E
Date	2-Sept-03
Test Type	3500 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	350
Preburn Time (sec)	83.66
Extinguishment Time (sec)	56.37
Wind Speed (mph)	4-5
Wind Direction	E
Temperature (°F)	90

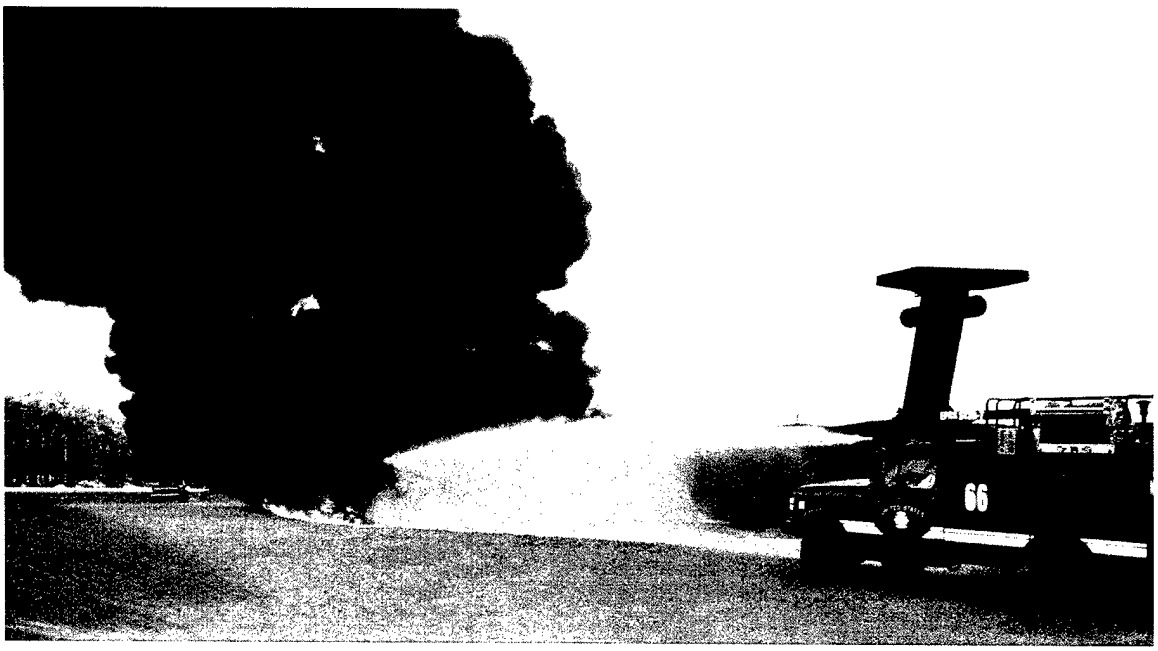

Figure 3. 3500 ft2 JP-8 Pool Fire using the EFSS Roof Turret.

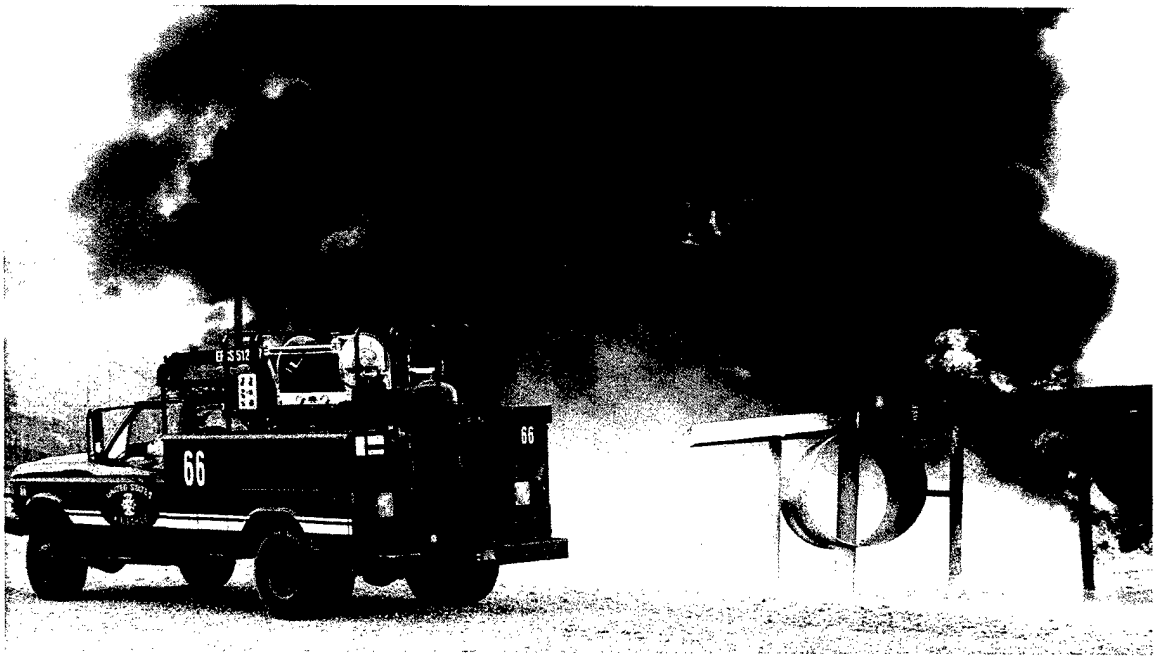

Figure 4. EFSS Fighting Hydrocarbon Pool Fire with Roof Turret.

Preburn times were dependent on wind speed, wind direction and any residual foam left in the pit from previous testing. Extinguishment time averaged 65.43 seconds (Tables 7-9).

3.3 7000 sq ft Pool Fires Using the Turret

Three full pit fires were completed using the roof turret on the EFSS. Approximately 1000 gallons of JP-8 fuel was used to obtain maximum fire coverage area. The agents were applied either separately, or in combination, to most effectively extinguish the fire.

The EFSS functioned normally during Test 3A and no problems with the equipment were noted. The preburn was 103.65 and the fire was extinguished in 111.47 seconds (Table 10).

Table 10. Test 3A Summary.

Test No	3A
Date	2-Sept-03
Test Type	7000 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	1000
Preburn Time (sec)	103.65
Extinguishment Time (sec)	111.47
Wind Speed (mph)	1-2
Wind Direction	na
Temperature (°F)	90

The EFSS functioned normally during Test 3B and no problems with the equipment were noted. The fire in Test 3B was more difficult to extinguish due to the shift in the wind direction from a northerly to an easterly direction. This caused a much more intense fire at the tail of the aircraft mockup due to residual fuel in the aggregate used to divide the pit in half. The system was depleted of dry chemical before the fire was completely contained, however, enough foam remained to finish extinguishing the fire. The preburn time was 84 seconds and the extinguishment time was extended at 175.47 seconds (Table 11).

Table 11. Test 3B Summary.

Test No	3B
Date	3-Sept-03
Test Type	7000 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	1000
Preburn Time (sec)	84.09
Extinguishment Time (sec)	175.47
Wind Speed (mph)	5
Wind Direction	N
Temperature (°F)	90

During Test 3C, the EFSS functioned normally and no problems were observed. The extinguishment time was shorter than in Test 3B at 126.22 because the wind changed direction to the west and the fire around the tail of the mockup was not as intense (Table 12).

Table 12. Test 3C Summary.

Test No	3C
Date	3-Sept-03
Test Type	7000 sq ft pool, Turret
Fuel Type	JP-8
Fuel Amount	970
Preburn Time (sec)	99.32
Extinguishment Time (sec)	126.22
Wind Speed (mph)	10-12
Wind Direction	W
Temperature (°F)	90

Preburn times were dependent on wind speed, wind direction and any residual foam left in the pit from previous testing. Extinguishment time averaged 137.72 seconds (Tables 10-12).

3.4 7000 sq ft Pool Fires Using the Handline

Three full pit fires were completed using the roof turret on the EFSS. Approximately 1000 gallons of JP-8 fuel was used to obtain maximum fire coverage area. The agents were applied either separately, or in combination, to

most effectively extinguish the fire. Because of the prevailing winds, all the full pit handline fires were attacked from the tail to the nose of the mockup.

During Test 4A, the EFSS functioned normally and no problems were observed. The extinguishment time for the fire was 144.72 seconds, including the time to navigate from one side of the pit to the other, which was done three times to completely extinguish the fire (Table 13). At the completion of the test, approximately 350 lbs of dry chemical and 60 gallons of foam were used to extinguish the fire.

Table 13. Test 4A Summary.

Test No	4A
Date	4-Sept-03
Test Type	7000 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	1000
Preburn Time (sec)	98.88
Extinguishment Time (sec)	144.72
Wind Speed (mph)	3-5
Wind Direction	SSE
Temperature (°F)	88

During Test 4B, the EFSS functioned normally and no problems were observed. The preburn time was 85.44 seconds and the extinguishment time was improved to 93.47 seconds (Table 14). Figures 5 and 6 show the handline operations on the 7000 ft^2 pool fires.

Table 14. Test 4B Summary.

Test No	4B
Date	4-Sept-03
Test Type	7000 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	800
Preburn Time (sec)	85.44
Extinguishment Time (sec)	93.47
Wind Speed (mph)	5-7
Wind Direction	W
Temperature (°F)	90

Figure 5. 7000 ft^2 JP-8 Pool Fire Using the EFSS Handline.

Figure 6. Handline Operations Using the EFSS Combined Agent System.

During Test 4B, the EFSS functioned normally and no problems were observed. The preburn time was 96.19 seconds and the extinguishment time was improved to 75.90 seconds (Table 15). Extinguishment time was slightly reduced because the pit was not fully involved. Approximately 30% of the pit area was not burning at the start of the test due to the fuel being blown to the front of the pit.

Table 15. Test 4C Summary.

Test No	4C
Date	4-Sept-03
Test Type	7000 sq ft pool, Handline
Fuel Type	JP-8
Fuel Amount	800
Preburn Time (sec)	96.19
Extinguishment Time (sec)	75.90
Wind Speed (mph)	5
Wind Direction	W
Temperature (°F)	90

Preburn times were dependent on wind speed, wind direction and any residual foam left in the pit from previous testing. Extinguishment time averaged 104.70 seconds (Tables 13-15).

3.5 3500 sq ft Pool Fires with F100 Using the Handline

The F100 engine nacelle mockup was developed by the AFRL to provide a standardized test for the evaluation of agents for running fuel or three dimensional (3-D) fires. While agents, such as AFFF, are highly effective at extinguishing hydrocarbon pool fires, they are often less effective in 3-D fires. The F100 consists of a 46.5 in diameter, 16 ft long cylinder with three sets of baffles obstructing two different nozzles spraying 2.5 gpm of fuel each. The spray fuel fire cannot be directly attacked with agent due to the baffles so the agent must be able to penetrate the nacelle, extinguish the running fuel fire and cool the hot metal components to prevent reignition. During all F100 fires, the fuel to the spray nozzles was flowed until the entire 3500 ft^2 pool fire plus F100 was extinguished, allowing for reignition if the nacelle was not sufficiently cooled. Figure 7 and 8 show exterior and interior of the F100 engine nacelle.

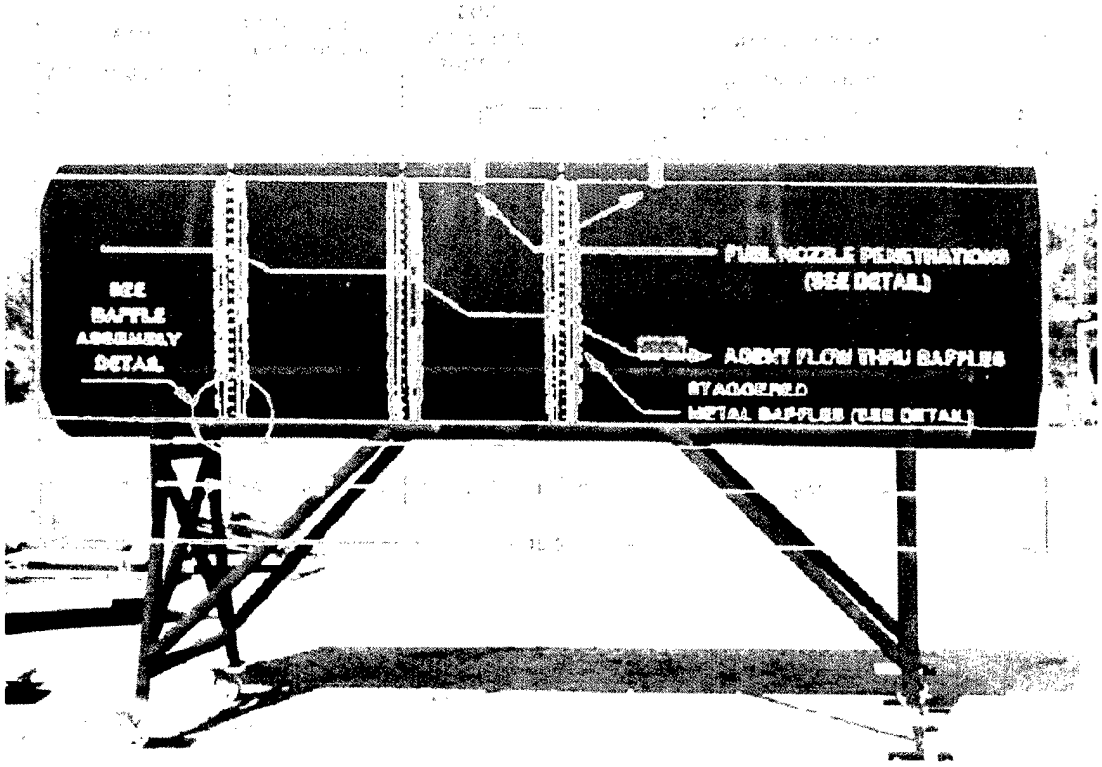

Figure 7. Picture/Schematic of the F100 Engine Nacelle Mockup.

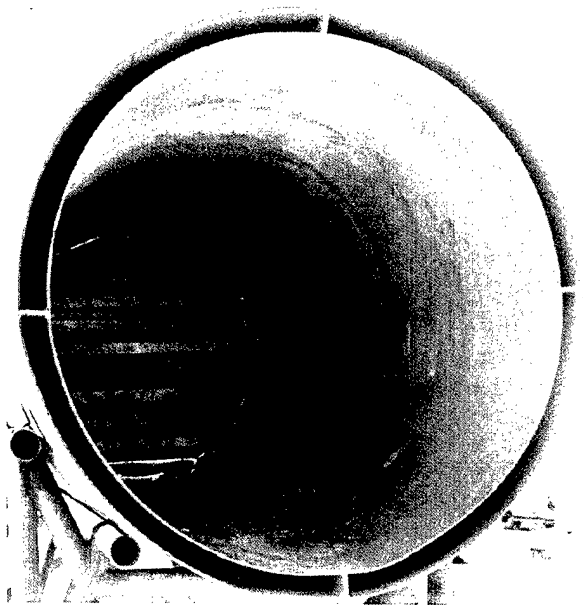

Figure 8. Interior View of the F100 Engine Nacelle Mockup Showing Baffles.

During Test 5A, the EFSS functioned normally and no problems were observed. The extinguishment time 68.22 seconds with a preburn of 78 seconds (Table 16). The preburn time for this fire was not sufficient to heat the F100 engine nacelle above the flashpoint of JP-8, which would cause reignition. Therefore, the fire was easier to suppress on the F100 than on the two subsequent fires where the nacelle was already heated.

Table 16. Test 5A Summary.

Test No	5A
Date	8-Sept-03
Test Type	3500 sq ft pool + F100, Handline
Fuel Type	JP-8
Fuel Amount	500 + 5 gpm
Preburn Time (sec)	78.06
Extinguishment Time (sec)	68.22
Wind Speed (mph)	5-6
Wind Direction	S
Temperature (°F)	85

During Test 5B, the EFSS functioned normally and no problems were observed. The extinguishment time was 52.66 seconds (15.5 seconds faster than 5A) with a heated engine nacelle (Table 17). The faster extinguishment time even with the heated engine nacelle was probably a result of the experience gained through the first fire.

Table 17. Test 5B Summary.

Test No	5B
Date	8-Sept-03
Test Type	3500 sq ft pool + F100, Handline
Fuel Type	JP-8
Fuel Amount	300 + 5 gpm
Preburn Time (sec)	95.94
Extinguishment Time (sec)	52.66
Wind Speed (mph)	2-3
Wind Direction	E
Temperature (°F)	88

During Test 5C, the EFSS functioned normally. The preburn time was 77.41 seconds and the extinguishment time was 90.47 seconds, or almost 38 seconds longer than Test 5B (Table 18). The longer extinguishment time was due to the direction the fire was fought. In Test 5A and B, the fire was attacked from the tail of the aircraft forward. In this attack mode, the F100 was approached from the back (or single set of baffles) to the front. Because only one set of baffles was obstructing the agent flow to the running fuel fire, the fire was easier to suppress. During Test 5C, the wind shifted and the fire was approached from the front of the F100, containing two sets of baffles. The two different attack approaches can be seen in Figures 9 and 10.

Problem: The pressure gauge on the dry chemical tank was malfunctioning and reading 25-30 psi even when all the pressure has been bled from the tank. Cause: This could be caused by excessive pressure to the gauge or an air pocket caused by caking of the dry chemical. Solution: The gauge was not replaced since this problem was not interfering with testing but should be replace before others use this unit. A snubber should be placed in line to prevent dry chemical from fouling the gauge.

Table 18. Test 5C Summary.

Test No	5C
Date	8-Sept-03
Test Type	3500 sq ft pool + F100, Handline
Fuel Type	JP-8
Fuel Amount	300 + 5 gpm
Preburn Time (sec)	77.41
Extinguishment Time (sec)	90.47
Wind Speed (mph)	4-5
Wind Direction	SE, SW Variable
Temperature (°F)	90

Preburn times were dependent on wind speed, wind direction and any residual foam left in the pit from previous testing. Extinguishment time averaged 70.45 seconds (Tables 16-18).

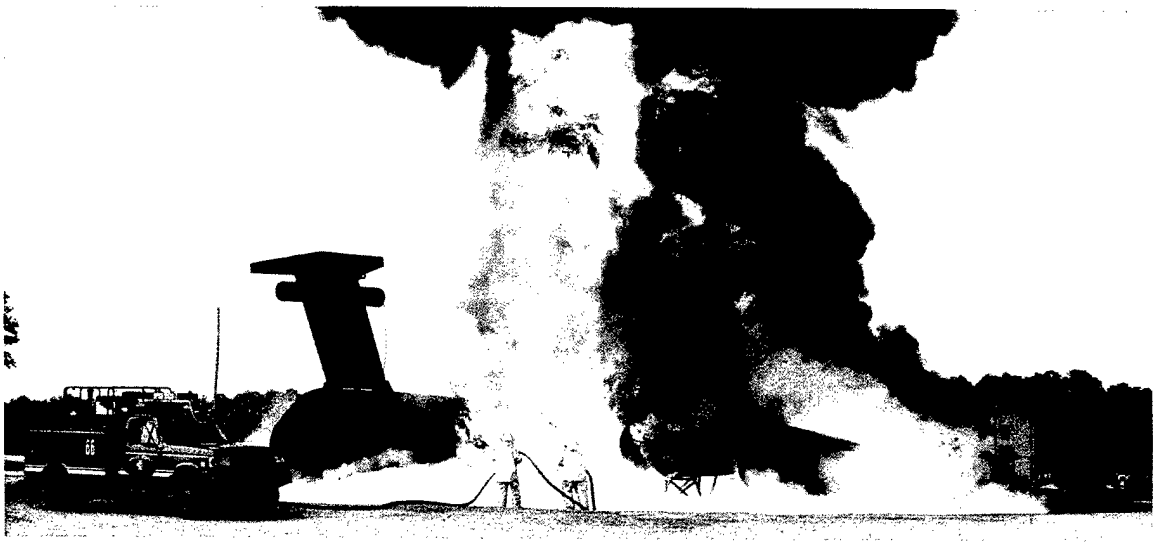

Figure 9. EFSS Handline Used to Extinguish F100 Fire From the Back of the Engine Nacelle.

Figure 10. EFSS Handline Used to Extinguish F100 Fire From the Front of the Engine Nacelle.

3.6 3500 sq ft Pool Fires with F100 Using the Turret

Three 3500 ft^2 pool plus F100 engine nacelle fires were extinguished using the EFSS roof turret. Because of the prevailing wind, all fires were approached from the tail of the aircraft forward. Approximately 500 gallons of fuel was used for the pool fire with 5 gpm of fuel spraying inside the F100 engine. The 5 gpm of fuel was flowed until the entire pool and engine fire were extinguished.

During Test 6A, the EFSS functioned normally and no problems were observed. The preburn time was 88.44 seconds and the extinguishment time was 112.78 seconds (Table 19). During Test 6A, all the dry chemical was expelled and the remaining foam was used to finish extinguishing the fire.

Table 19. Test 6A Summary.

Test No	6A
Date	8-Sept-03
Test Type	3500 sq ft pool + F100, Turret
Fuel Type	JP-8
Fuel Amount	500 + 5 gpm
Preburn Time (sec)	88.44
Extinguishment Time (sec)	112.78
Wind Speed (mph)	2-3
Wind Direction	S
Temperature (°F)	90

The EFSS functioned normally during the initial attack for Test 6B. The preburn time was 108 seconds and the extinguishment time was 84.59 seconds (Table 20).

Problem: After the main fire was extinguished and the firefighter went back to extinguished a residual fire in the rocks, the foam system did not operate immediately. The foam flow switch was turned off, and then turned on again. The second time the switch was turned back on, the foam flow resumed. The battery level was checked and found to be in an acceptable range. Cause: the air that controls the solenoid valves comes from the foam high pressure tank. If the high pressure air is being diverted to pressurize the foam tank or most of the high pressure air has been used, sufficient pressure may not exist to operate the valves. Solution: the control air should divert from either the foam or dry chemical high pressure tank containing the highest pressure. AFRL will attempt to verify these conclusions during performance specification testing.

Table 20. Test 6B Summary.

Test No	6B
Date	9-Sept-03
Test Type	3500 sq ft pool + F100, Turret
Fuel Type	JP-8
Fuel Amount	500 + 5 gpm
Preburn Time (sec)	108.00
Extinguishment Time (sec)	84.59
Wind Speed (mph)	4-5
Wind Direction	W
Temperature (°F)	85

During Test 6C, the EFSS functioned normally and no problems were observed. The preburn time was 186 seconds and the extinguishment time was 93.66 seconds (Table 21). The extended preburn time was due to burn off of the residual foam in the pit from the previous test. Figure 11 and 12 show the EFSS using the roof turret to extinguish the F100 engine nacelle.

Table 21. Test 6C Summary.

Test No	6C
Date	9-Sept-03
Test Type	3500 sq ft pool + F100, Turret
Fuel Type	JP-8
Fuel Amount	300 + 5 gpm
Preburn Time (sec)	186.00
Extinguishment Time (sec)	93.66
Wind Speed (mph)	2-3
Wind Direction	W
Temperature (°F)	90

Figure 11. EFSS Roof Turret Extinguishing Combination Pool and Running Fuel Fire.

Figure 12. EFSS Roof Turret Extinguishing F100 Engine Fire.

4 Conclusions

The EFSS performed well in the live fire evaluations conducted at Tyndall AFB, FL. The system consistently showed the capability to extinguish both pool and running fuel fires. Several minor problems were encountered with the system but were quickly resolved by the manufacturer and the equipment was put back into service. Issues with the switch covers and the additional capacity on the high pressure air will need to be addressed by the manufacturer in subsequent units.

5 Recommendations

Installing filters in line with the regulators to prevent fouling. Even though the regulator failure was not linked to debris, filters are recommended to prevent debris from fouling the regulators.

The switch covers on the control panel below the hose reel need to be changed to a quarter/half turn type that cannot be bumped in the off position by the hose line.

The control air for the solenoid valves needs to be redundant (tied to foam and dry chemical high pressure tanks), so that the air supplying the valves will come from the high pressure tank with the greatest pressure.

The compressed air on the EFSS is only sufficient to deliver the foam/dry chemical and blow down the system. The size of the high pressure tanks should be slightly larger to assure control of the solenoid valves even when the agents have been completely dispensed as well as to have a minimum of compressed air in the tanks to keep moisture out.